

1.2 Elasticity: Price elasticity of demand (PED)

Learning Outcomes

- Explain the concept of price elasticity of demand, understanding that it involves responsiveness of quantity demanded to a change in price, along a given demand curve.
- Calculate PED using the following equation: $\text{PED} = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$
- State that the PED value is treated as if it were positive although its mathematical value is usually negative.
- Explain using diagrams and PED values, the concepts of price elastic demand, price inelastic demand, unit elastic demand, and perfectly inelastic demand.
- Explain the determinants of PED, including the number and closeness of substitutes, the degree of necessity, time, and the proportion of income spent on the good.

What is price elasticity of demand and how is it calculated?

Price elasticity of demand (PED) measures the responsiveness of **quantity demanded** for a good to a change in its price.

It is calculated using the formula $\text{PED} = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}} = \frac{\% \Delta Q_d}{\% \Delta P}$

Δ is the Greek letter delta. It is used in mathematics and means 'change in'.

This formula is used when the changes are given in percentages.

Subject vocabulary

price elasticity of demand (PED) a measure of how quantity demanded responds to a change in price in percentage terms

quantity demanded the amount of a good consumers are willing and able to buy at a given price over a given period of time

Calculation of PED using the formula $\text{PED} = \frac{\% \Delta Q_d}{\% \Delta P}$ – a step-by-step guide

Trouble shooter

Price falls by 6% leading to an increase in quantity demanded of 9%.

I will enter the percentage changes into the formula:

$\text{PED} = \frac{9}{-6}$ simplify by dividing 9 by -6
($\% \Delta P$ is negative because price has decreased)

$\text{PED} = -1.5$ (PED is negative because a positive number divided by a negative number gives a negative number)

When the changes are in raw values we use the formula:

$\text{PED} = \frac{\Delta Q_d / Q_d}{\Delta P / P}$ ($\Delta Q_d / Q_d$ means ΔQ_d divided by Q_d)
($\Delta P / P$ means ΔP divided by P)

ΔQ_d is the change in quantity demanded, Q_d is the original quantity demanded, ΔP is the change in price and P is the original price.

Calculation of PED using the formula $\text{PED} = \frac{\Delta Q_d / Q_d}{\Delta P / P}$ – a step-by-step guide

Trouble shooter

Price increases from \$3 to \$9 causing quantity demanded to fall from 12,000 units to 4000 units.

$\Delta Q_d = -8,000$ units (it is negative because quantity demanded falls).

Original $Q_d = 12,000$ units, $\Delta P = \$3$ to $\$9 = \6 (it is positive because price has increased) and Original price = \$3.

Now the calculations are added into the formula:

$\text{PED} = \frac{-8000/12000}{6/3}$ simplify by dividing -8000 by 12,000 and by dividing 6 by 3

$\text{PED} = \frac{-0.67}{2}$ Simplify by dividing -0.67 by 2

$\text{PED} = -0.34$ (PED is negative because a negative number divided by a positive number gives a negative number)

How to calculate an unknown value when all the other values are known – a step-by-step guide

Trouble shooter

Calculation of the change in quantity demanded caused by a change in price when the original price, the change in price, the original quantity demanded, and the value of PED are known.

$P = \$4$, new price = $\$6$, original quantity demanded = 120 units, and $PED = -0.5$

The figures are entered into the formula $PED = \frac{\Delta Q_d / Q_d}{\Delta P / P}$

$$-0.5 = \frac{\Delta Q_d / 120}{2/4} \text{ simplify by dividing 2 by 4}$$

$$-0.5 = \frac{\Delta Q_d / 120}{0.5} \text{ simplify by multiplying both sides of the equation by 0.5}$$

$$-0.25 = \Delta Q_d / 120 \text{ simplify by multiplying both sides of the equation by 120}$$

$$-30 = \Delta Q_d$$

New quantity demanded = original $Q_d - \Delta Q_d$

$$120 - 30 = 90$$

An increase in price from $\$4$ to $\$6$ causes quantity demanded to fall from 120 units to 90 units.

Subject vocabulary

inverse relationship a change in the value of one variable leads to an opposite change in direction in the value of the other variable. For example an increase in price leads to a fall in quantity demanded.

law of demand states that there is a negative causal relationship between price and quantity demanded. As price rises quantity demanded falls.

demand curve a graph that shows the relationship between price and quantity demanded

absolute value the distance a number is from zero (e.g. the absolute value of 5 is 5 and the absolute value of -5 is 5)

price elastic the percentage change in quantity demanded/supplied > the percentage change in price

price inelastic the percentage change in quantity demanded/supplied < the percentage change in price

price unit elastic the percentage change in quantity demanded / supplied = the percentage change in price. $PED/PES = 1$

Why is the value of PED negative?

A price increase is a positive change and it causes quantity demanded to fall which is a negative change and as price falls (negative change) quantity demanded rises (positive change). So price and quantity demanded have an **inverse relationship** reflecting the **law of demand**. In order to work out PED the percentage change in quantity demanded is divided by the percentage change in price. When one value is positive the other value is negative. A negative number divided by a positive number gives a negative number (minus divided by plus is minus) and a positive divided by a negative gives a negative (plus divided by minus is minus). As the value of PED is always negative economists often ignore the minus sign.

Explain using diagrams and PED values, the concepts of price elastic demand, price inelastic demand, unit elastic demand, and perfectly inelastic demand

Figure 8.1a and 8.1b show **demand curves** for two different goods served during one week at a cafe.

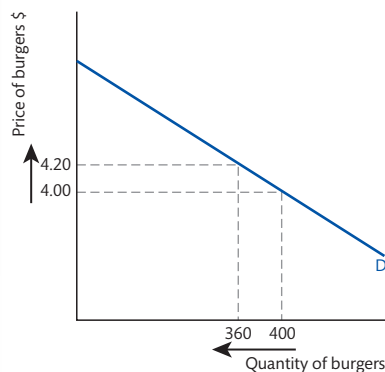


Figure 8.1a

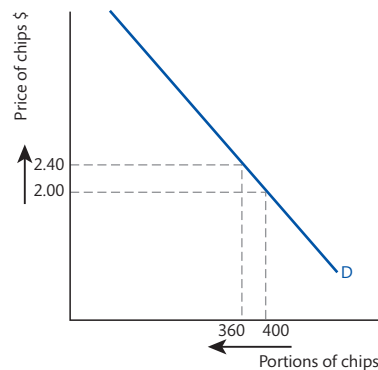


Figure 8.1b

In Figure 8.1a an increase in price of 5% causes quantity demanded to fall by 10%: $PED = -10/5 = (-) 2$. The $\% \Delta Q_d > \% \Delta P$ so the **absolute value** of PED is greater than 1 (ignoring the minus sign) and demand is **price elastic**. In Figure 8.1b a price rise of 20% causes quantity demanded to fall by 10%. $PED = -10/20 = 0.5$ (ignoring the minus sign). The $\% \Delta Q_d < \% \Delta P$ so the absolute value of PED is less than 1 and demand is **price inelastic**. When $\% \Delta Q_d = \% \Delta P$ the absolute value of PED is equal to 1 and demand is **price unit elastic**.

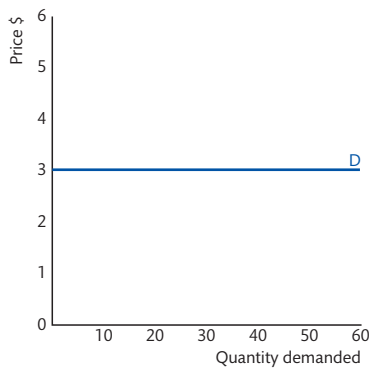


Figure 8.2

In Figure 8.2 at a price of \$3 quantity demanded has no end. It is infinite. As price changes, quantity demanded falls from infinity to zero. To reflect this the demand curve is horizontal at price. As price changes, the change in quantity demanded is infinite. Any number divided by or into infinity equals infinity. A 5% increase in price for example causes quantity demanded to fall from infinity to zero.

$$PED = \frac{\% \Delta Q_d}{\% \Delta P} \quad PED = \frac{\infty}{5} = \infty \quad (\infty \text{ means infinity}).$$

Demand is **perfectly elastic** with respect to price.

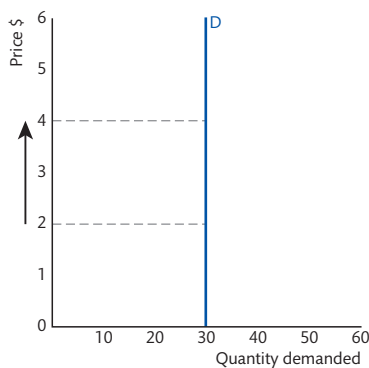


Figure 8.3

In Figure 8.3 a change in price causes no change in quantity demanded. The change in quantity demanded = 0. Quantity demanded is 30 units at all prices. To reflect this the demand curve is vertical at 30 units. Any number divided by or into 0 equals 0. Price increases from \$2 to \$4. This is a 100% increase causing quantity demanded to change by 0. To reflect this the demand curve is vertical at 30 units.

$$PED = \frac{\% \Delta Q_d}{\% \Delta P} = \frac{0}{100} = 0.$$

Demand is **perfectly inelastic** with respect to price.

Model sentence: The value of PED is determined by the relative size of the percentage change in price and quantity demanded: when the percentage change in quantity demanded is greater than the percentage change in price, PED has an absolute value greater than 1 and demand is price elastic and when the percentage change in quantity demanded is less than the percentage change in price, PED has an absolute value less than 1 and demand is price inelastic.

Explain how PED is determined

Quantity demanded of a good is more responsive to a change in its price when there are lots of close **substitutes** available for consumers to buy instead of the good. Demand is more price elastic.

If a good is a **necessity** (e.g. oil) quantity demanded is less responsive to a change in its price and demand is more price inelastic. Demand for luxury goods is more price elastic than for necessities because **consumption** of luxury goods is not essential.

If a good is **addictive** (e.g. tobacco) it is more difficult to reduce consumption following an increase in price. Therefore demand is more price inelastic.

It is difficult for consumers to immediately change patterns of consumption. It takes time to find suitable substitutes and to ration use of a good following an increase in price. Over a short period of time demand is more price inelastic but becomes less price inelastic over time, as consumers are able to find substitutes and reduce consumption further.

The price of some goods is very low. **Expenditure** on them makes up a very small **proportion** of a consumer's income so that even after a large increase in price there is little or no change in quantity demanded. If the price of a box of matches increases by 15% the change in quantity demanded would be much less than 15%, therefore demand is price inelastic.

Model sentence: The more close substitutes there are available on the market the easier it is for consumers to switch **expenditure** and buy an alternative good, therefore demand for a good with many close substitutes will be more price elastic.

Subject vocabulary

perfectly elastic demand at a particular price quantity demanded is infinite but falls to nothing as price changes. The absolute value of PED is equal to infinity.

perfectly inelastic demand quantity demanded does not change as price changes. The absolute value of PED is equal to zero.

substitutes in production two or more goods that can be produced by a firm

necessity a consumer good or a producer good that is important to the producer or consumer and has few or no substitutes, therefore its PED tends to be inelastic. Also describes a good that is income inelastic.

expenditure the price paid by buyers in exchange for goods and services. Total expenditure = price × quantity purchased.

Synonyms

consumption.... use

proportion..... amount

expenditure spending/
money spent

Glossary

addictive something your body needs regularly and you cannot stop taking it

Test your understanding of this unit by answering the following questions

- Explain why the value of PED is negative.
- Calculate the PED when price falls by 25% causing quantity demanded to increase by 75%.
- Calculate PED when a price increase from \$4 to \$6 causes quantity demanded to fall from 1200 units to 1000 units.
- Quantity demanded = 150 units at \$16. Price increases to \$20 and PED for the good = 0.25. Calculate the change in quantity demanded.
- Explain why as income rises PED for most goods becomes less elastic.
- Explain why demand for cigarettes is inelastic. Use a diagram to illustrate your answer.

Learning Outcomes

- Calculate PED between two **designed** points on a demand curve using the PED equation.
- Explain why PED varies along a straight line demand curve and is not represented by the slope of the demand curve.
- Examine the role of PED for firms in making decisions regarding price changes and their effect on total revenue.
- Explain why PED for many primary goods is relatively low and the PED for manufactured goods is relatively high.
- Examine the significance of PED for government in relation to indirect taxes.

Calculate and explain PED along a straight line demand curve (see Figure 9.1a/b)

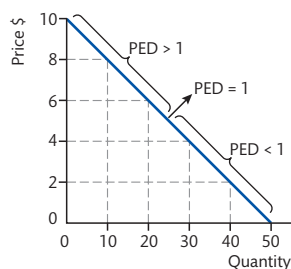


Figure 9.1a

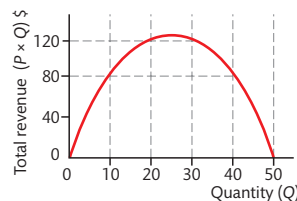


Figure 9.1b

As price increases from \$2 to \$4 **quantity demanded** falls from 40 to 30 units. (See pages 19–21 for a detailed explanation of how to calculate PED.)

Synonyms

designed..... chosen/
selected

diminishing becoming
smaller

Subject vocabulary

quantity demanded the amount of a good consumers are willing and able to buy at a given price over a given period of time

price inelastic the percentage change in quantity demanded/supplied < the percentage change in price

revenue the income a firm receives from consumers in exchange for goods (revenue = price × quantity sold)

price elastic the percentage change in quantity demanded/supplied > the percentage change in price

$$PED = \frac{\Delta Q_d / Q_d}{\Delta P / P} = \frac{-10/40}{2/2} = \frac{-0.25}{1} = (-) 0.25.$$
 PED < 1 so demand is **price inelastic**. Remember when stating the value of PED that the minus sign is ignored – it is treated as a positive.

Revenue = price × quantity. When price is \$2 revenue = \$2 × 40 = \$80.

When price is \$4 revenue = \$4 × 30 = \$120, an increase of \$40. As price rises from \$2 to \$4 revenue increases by \$40. As price falls from \$4 to \$2 revenue falls from \$120 to \$80, a fall of \$40.

Therefore when demand is price inelastic an increase in price leads to an increase in revenue and a fall in price leads to a fall in revenue because the percentage change in price is greater than the percentage change in quantity demanded.

As price increases from \$6 to \$8 quantity demanded falls from 20 to 10 units.

$$PED = \frac{-10/20}{2/6} = \frac{-0.5}{0.33} = -1.51.$$
 PED > 1 so demand is **price elastic**.

When price is \$6 revenue = \$6 × 20 = \$120. When price is \$8 revenue = \$8 × 10 = \$80, a fall of \$40. As price rises from \$6 to \$8 revenue falls from \$120 to \$80, a decrease of \$40. As price falls from \$8 to \$6 revenue increases from \$80 to \$120, a rise of \$40.

Therefore, when demand is price elastic an increase in price leads to a fall in revenue and a fall in price leads to an increase in revenue, because the percentage change in quantity demanded is greater than the percentage change in price.

The **slope** remains constant moving along a straight line **demand curve**. The measure of the slope of the demand curve is in absolute terms. For example, a price increase of \$2 from \$2 to \$4 causes a fall in quantity demanded from 40 to 30 units and a price increase of \$2 from \$6 to \$8 causes a fall in quantity demanded from 20 to 10 units. In both cases price changes by \$2 causing quantity demanded to change by 10 units. PED, on the other hand, measures the relationship between a percentage change in price and a percentage change in quantity demanded. It is measured in relative terms. A change in price or quantity when price or quantity is low results in a relatively large percentage change. A change in price or quantity when price or quantity is high results in a relatively small percentage change. For example, a price increase of \$2 from \$2 to \$4 is a 100% increase in price whereas a price increase of \$2 from \$6 to \$8 is only a 33.33% increase in price, even though the actual price in both cases changes by the same amount.

Explain the relationship between PED and total revenue (see Figure 9.1a/b)

At first, as price increases from zero the percentage change in price > the percentage change in quantity demanded. Demand is price inelastic, therefore revenue increases as price rises. As price continues to rise it causes a movement up and along the demand curve. Price elasticity of demand becomes less price inelastic, because the difference between the rate at which price and quantity demanded changes begins to fall. While the percentage change in price is greater than that of quantity demanded, revenue will continue to rise as price increases, but at a **diminishing** rate. This means that, as price increases, the addition to total revenue is positive, but the increase in total revenue is less than the increase gained by the previous increase in price. When the percentage change in price = the percentage change in quantity demanded, total revenue is **maximized**. The value of PED = 1 and demand is **unit price elastic**. This occurs halfway along the straight line demand curve at a price of \$5 and a quantity of 25 units.

As price increases above \$5 the percentage change in quantity demanded > the percentage change in price, therefore revenue begins to fall. As price continues to rise, PED becomes more elastic. Total revenue falls at an increasing rate until price is \$10 and quantity demanded is 0 and there is no revenue.

Revenue maximization

If a firm's **output** and price is at a point on the demand curve where PED is inelastic the firm can increase revenue by increasing price and reducing output. If output and price is at a point where PED is elastic the firm can increase revenue by lowering price and increasing output. Therefore, in order to maximize revenue, a firm sets output or price where PED = 1 and demand is unit price elastic.

Model sentence: When the absolute value of PED is less than 1 increasing price causes revenue to rise and when the absolute value of PED is more than 1 reducing price causes revenue to rise, therefore revenue is maximized when the absolute value of PED = 1.

Examine the role of PED for firms in making decisions regarding price changes and their effect on total revenue

A firm launching a new good wants to maximize revenue over the life of the good. The firm will try to get individual consumers to pay the most they are willing to pay. In other words the firm tries to steal as much **consumer surplus** as possible. Initially the firm charges a high price and a quantity of units are sold to less price-sensitive consumers who are willing and able to pay the high price. When **demand** of these consumers has been met and sales begin to fall the firm lowers price at a point on the demand curve where PED is inelastic, more consumers enter the **market** to buy the good, and revenue increases. Over time the firm continues to lower the price in order to increase quantity demanded and increase revenue. This **pricing strategy** is called skimming the market and is particularly used by firms producing new technological goods. In **industries** where there are firms producing **branded goods** a new firm might reduce the price of its new good in order to gain **market share**. As brand awareness rises and the good is established in the market, PED becomes more inelastic and the firm can raise the price and increase revenue.

Why is PED for primary goods lower than the PED for manufactured goods?

Primary goods such as wheat have fewer **substitutes** than **manufactured goods**. Primary goods are more likely to be **necessities**. Manufactured goods are often **luxuries**. In countries where incomes are relatively high consumers spend a lower proportion of income on primary goods and a higher proportion on manufactured

Glossary

slope the angle/gradient of the curve

maximized made as great as possible

Subject vocabulary

demand curve a graph that shows the relationship between price and quantity demanded

unit price elastic the percentage change in quantity demanded / supplied = the percentage change in price. PED/PES = 1.

output the quantity of goods produced by a firm, industry or economy

consumer surplus the difference between the price a consumer is willing and able to pay and the price the consumer actually pays

demand the amount of a good that consumers are willing and able to buy at each price

market where buyers and sellers meet to exchange money for goods and services

pricing strategy a plan made and used by a firm with the aim of increasing revenue and profits through the setting of price

industry a group of firms that produce the same or similar goods or services

branded goods goods that are identifiable as being the product of a particular firm usually through a distinctive label or logo

market share the proportion of the market supply of a good or service that is controlled by a firm

primary good a good that has not been processed and is in a raw state (e.g. fruit/wheat)

substitutes in production two or more goods that can be produced by a firm

manufactured goods goods produced from raw materials

necessities consumer goods or producer goods that are important to the producer or consumer and few or no substitutes, therefore their PED tends to be inelastic. Also describes goods that are income inelastic.

luxuries when income changes demand for a luxury good changes at a greater rate. Demand is relatively sensitive to changes in income.

Subject vocabulary

unemployment occurs when there are people actively looking for work at the equilibrium wage rate but are not able to find work

industry a group of firms that produce the same or similar goods or services

tax revenue the income the government receives through the levying and collection of taxes

Synonyms

duty tax

concept(s) idea(s)/ theory/ies

responsiveness reaction/ sensitivity

goods. Therefore quantity demanded of primary goods is less sensitive to a change in price than quantity demanded of manufactured goods. Therefore the value of PED is likely to be lower and demand less price elastic for primary goods than for manufactured goods.

Examine the significance of PED for government in relation to indirect taxes

An indirect tax is a tax imposed on producers by the government. It is a tax placed on a good or service. Examples include **duties** on cigarettes, alcohol, fuel, and value added tax (VAT).

When a government increases the duty on a good, the price of the good increases leading to a fall in quantity demanded. If demand is highly price elastic the rate of change in quantity demanded > the rate of change in price and a duty that raises price will cause a large decrease in sales increasing **unemployment** in the **industry**. The government places taxes on goods that are more price inelastic because the fall in quantity of goods bought is not as great, therefore there are not as many job losses and the **tax revenue** (tax per unit × quantity sold) collected by the government from the sale of the goods will be greater.

Test your understanding of this unit by answering the following questions

- Explain why revenue is maximized when the absolute value of PED = 1. Use a diagram to illustrate your answer.
- Explain why PED is lower for primary goods than for manufactured goods.

Learning Outcomes

- Outline the **concept** of **cross-price elasticity of demand**, understanding that it involves **responsiveness** of demand for one good (and hence a **shifting** demand curve) to a change in the price of another good.
- Calculate XED using the following equation
$$\text{XED} = \frac{\text{percentage change in quantity demanded of good } x}{\text{percentage change in price of good } y}$$
- Show that substitute goods have a positive value of XED and **complementary goods** have a negative value of XED.
- Explain that the (absolute) value of XED depends on the closeness of the relationship between two goods.
- Examine the **implications** of XED for businesses if prices of substitutes or complements change.

Subject vocabulary

cross-price elasticity of demand (XED) measures the responsiveness of demand for one good to a change in price of another good in percentage terms

complementary goods/ complements goods that are used together

quantity demanded the amount of a good consumers are willing and able to buy at a given price over a given period of time

demand curve a graph that shows the relationship between price and quantity demanded

Synonyms

shifting moving

implications effects/ outcomes

relatively comparatively

Calculation of XED

XED measures the responsiveness of demand for one good to a change in the price of another good.

It is calculated using the formula
$$\text{XED} = \frac{\text{percentage change in quantity demanded of good } x}{\text{percentage change in price of good } y}$$

How does the price of one substitute affect the demand for the other? – a step-by-step guide

Trouble shooter

Goods 'X' and 'Y' are substitutes: one good can be used in place of the other. As the price of good 'Y' increases it becomes **relatively** more expensive than good 'X'. Some consumers buy good 'X' in place of good 'Y'. This leads to a fall in **quantity demanded** for good 'Y' (a movement up and along the **demand curve**) and an increase in demand for good 'X' (a shift up and to the right of the demand curve).

As the price of good 'Y' falls it becomes relatively cheaper than good 'X'. Some consumers buy good 'Y' in place of good 'X' leading to an increase in quantity demanded for good Y (a movement down and along the demand curve) and a fall in demand for good X (a shift down and to the left of the demand curve).

Model sentence: In the case of two substitutes an increase in the price of one leads to a fall in quantity demanded of that good (a movement up and along its demand curve) and an increase in demand for the other good (a shift up and to the right of its demand curve).

Calculate XED and explain why it is always positive in the case of substitutes

There are two **barber** shops in the high street, John's and Sam's. John increases the price of a haircut from £20 to £25. Some customers go to Sam's instead of John's. Quantity demanded of haircuts at John's falls and demand for haircuts at Sam's increases from 100 a week to 150.

How to calculate XED from the information above – a step-by-step guide

Trouble shooter

Use the formula $XED = \frac{\Delta Q_{dX}/Q_{dX}}{\Delta P_Y/P_Y}$

ΔQ_{dX} is the change in quantity demanded for service X, Q_d is the original quantity demanded for service X, ΔP_Y is the change in price of service Y, and P is the original price of service Y.

$$XED = \frac{50/100}{5/20} \quad \text{simplify by dividing 50 by 100 and 5 by 20}$$

$$XED = \frac{0.5}{0.25} \quad \text{simplify by dividing 0.5 by 0.25}$$

$$XED = 2$$

There is a **positive correlation** between the price of one good and the demand for another when the goods are substitutes. An increase in price of one good causes an increase in demand for the other. A positive divided by a positive equals a positive.

If John reduces the price some customers have their haircut at John's instead of Sam's leading to an increase in quantity demanded at John's and a fall in demand at Sam's. The fall in price of one service leads to a fall in demand for the other. A negative divided by a negative equals a positive. Therefore the value of XED for substitutes is always positive.

The services are close substitutes: one can easily be **consumed** in place of the other. The demand for one service is very sensitive to a change in the price of the other.

The greater the similarity between two goods the more responsive demand for one good is to a change in the price of the other and the higher the value of XED.

How does the XED of substitutes affect businesses?

It is useful for a firm to know the effect on demand for their good when a **rival business** changes its price and the effect on demand for a rival's good when it changes price. This knowledge helps firms develop a **pricing strategy** that increases **revenue** and **profit**.

How does the price of one complementary good affect the demand for the other? – a step-by-step guide

Trouble shooter

Goods 'X' and 'Y' are complements: they are used together. As the price of good 'Y' falls quantity demanded increases (a movement down and along its demand curve). As more of good 'Y' is sold demand for good 'X' which is used with good 'Y' increases (a shift up and to the right of the demand curve).

As the price of good 'Y' increases quantity demanded falls (a movement up and along its demand curve). As less of good 'Y' is sold demand for good 'X' decreases (a shift down and to the left of the demand curve).

Model sentence: In the case of complementary goods an increase in the price of one good leads to a fall in quantity demanded of that good (a movement up and along its demand curve) and a fall in demand for the other good (a shift to the left of its demand curve).

Glossary

barber a shop where men's hair is cut

Subject vocabulary

positive correlation a relationship between two variables such that they move in the same direction

rival business a competitor

pricing strategy a plan made and used by a firm with the aim of increasing revenue and profits through the setting of price

revenue the income a firm receives from consumers in exchange for goods (revenue = price × quantity sold)

profit the difference between total revenue and total cost

Synonyms

correlation..... link/
relationship

consumed used

Subject vocabulary

inverse relationship a change in the value of one variable leads to an opposite change in direction in the value of the other variable

unrelated goods goods that are not linked in their use

Synonyms

concept(s)..... idea(s)/ theory/ies

shifting..... moving

Calculate XED and explain why it is always negative in the case of complements

The price of using mobile phones falls and quantity demanded increases, leading to a movement down and along the demand curve. As more phones are sold the demand for 'apps' (applications) increases causing the demand curve for apps to shift up and to the right.

The price of mobile phones falls by 10% and this leads to a 25% increase in quantity demanded of 'apps'.

$$\text{XED} = \frac{\% \Delta Q_d X}{\% \Delta P_Y} = \frac{25\%}{-10\%} = -2.5$$

Let's say the price of using mobile phones increases by 10% leading to a 25% fall in quantity demanded of 'apps'.

$$\text{XED} = \frac{-25\%}{10\%} = -2.5$$

The value of XED is always negative in the case of complements because of the **inverse relationship** between the price of one good and the demand of the other. A positive divided by a negative equals a negative. A negative divided by a positive equals a negative.

Lots of people use 'apps' on their mobile phones, therefore the number of phones sold has a large impact on the demand for 'apps'. Demand for 'apps' is highly responsive to changes in the price of mobile phones. The stronger the relationship between the two complementary goods the higher the negative value of XED.

How does the XED of complements affect businesses?

Trips to the cinema and confectionery and fizzy drinks are strong complements. The profit on the sale of confectionery and drinks at the cinema is very high. The owner knows how much on average each customer spends on these items. Reducing the price of cinema tickets to attract more customers will lead to an increase in demand for confectionery and drinks. It is possible that this pricing strategy might increase profits overall.

Unrelated goods

Goods are unrelated when an increase in the price of one good does not affect the demand for the other.

Test your understanding of this unit by answering the following questions

- Explain why the value of XED is positive in the case of substitutes.
- Calculate the XED when price of one good falls from \$9 to \$6 causing quantity demanded for the other good to increase from 120,000 units to 200,000 units. Comment on the relationship between the two goods.
- 'As the price of petrol increases demand for more fuel-efficient cars will increase'. Using the concept of cross-price elasticity of demand, comment on the validity of this comment.

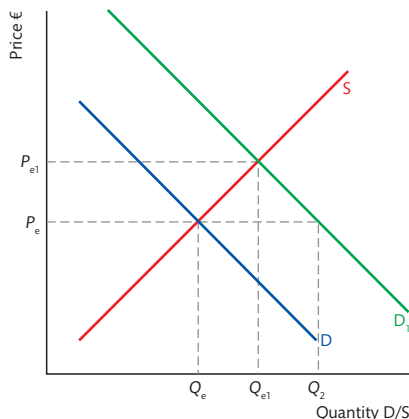
Learning Outcomes

- Outline the **concept** of income elasticity of demand, understanding that it involves responsiveness of demand (and hence a **shifting** demand curve) to a change in income.
- Calculate YED using the following equation
$$\text{YED} = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$
- Show that normal goods have a positive value of YED and inferior goods have a negative value of YED. Distinguish, with reference to YED, between necessity (income inelastic) goods and luxury (income elastic) goods.
- Examine the implications for producers and for the economy of a relatively low YED for primary goods, a relatively higher YED for manufactured goods, and an even higher YED for services.

How does a change in income affect demand in the case of normal goods?

Income elasticity of demand measures the **responsiveness** of **quantity demanded** to a change in **income**.

It is calculated by using the formula $YED = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$



As income increases, **demand** for flights increases, leading to a shift up and to the right of the **demand curve** and **excess demand** ($Q_2 - Q_{e1}$) at the **equilibrium price** P_{e1} . Price increases to **eliminate** the excess. As price rises there is a movement up and along the **supply curve** and up and along the new demand curve D_1 . Price rises until quantity demanded = **quantity supplied** at P_{e1} . An increase in income causes price to rise from P_e to P_{e1} and quantity demanded and supplied to increase from Q_e to Q_{e1} . A fall in income leads to a shift down and to the left of the demand curve and a fall in equilibrium price and quantity demanded and supplied.

Figure 11.1

Calculate YED – a step-by-step guide

Trouble shooter

A consumer's income increases from \$30,000 to \$40,000 leading to an increase in quantity demanded from 120 to 160 units. The formula used to calculate YED when not given the changes in percentage terms is

$$YED = \frac{\Delta Q_d / Q_d}{\Delta Y / Y}$$

ΔQ_d is the change in quantity demanded, Q_d is the original quantity demanded, ΔY is the change in income, and Y is the original income.

$$YED = \frac{40/120}{10\,000/30\,000} \quad \text{simplify by dividing 40 by 120 and 10\,000 by 30\,000}$$

$$YED = \frac{0.33}{0.33}$$

$$YED = 1$$

The proportional change in quantity demanded (0.33) = the proportional change in income (0.33)
YED = 1 and demand is income unit elastic.

There is a **positive correlation** between income and quantity demanded for **normal goods** (income and quantity demanded change in the same direction). Therefore the value of YED for a normal good is positive: a positive number divided by a positive number gives a positive number and a negative divided by a negative gives a positive.

What is the difference between normal goods that are necessities and those that are luxuries?

When the proportional change in quantity demanded < the proportional change in income YED is less than 1. This means that quantity demanded is relatively insensitive to changes in income. Demand is **income inelastic** and goods are described as **necessities**. For example, a fall of 3% in income leads to a 0.6% fall in the quantity of bread demanded.

$$YED = \frac{\% \Delta Q_d}{\% \Delta Y} = \frac{-0.6}{-3} = 0.2 \quad YED \text{ is positive and less than 1, therefore bread is a necessity.}$$

Subject vocabulary

income elasticity of demand a measure of how quantity demanded responds to a change in income in percentage terms

quantity demanded the amount of a good consumers are willing and able to buy at a given price over a given period of time

income the payment received by the factors of production (e.g. wages paid to labour, rent paid to the owners of land)

demand the amount of a good that consumers are willing and able to buy at each price

demand curve a graph that shows the relationship between price and quantity demanded

excess demand occurs when quantity demanded is greater than quantity supplied

equilibrium price the price at which the quantity consumers are willing and able to buy is equal to the quantity firms are willing and able to produce

supply curve a graph that shows the relationship between price and quantity supplied

quantity supplied the amount of a good that firms are willing and able to produce at a given price over a given period of time

positive correlation a relationship between two variables such that they move in the same direction

normal goods goods for which demand increases when income increases, and falls when income falls

income inelastic demand for a good is income inelastic when the value of income elasticity of demand is positive and less than 1

necessities consumer goods or producer goods that are important to the producer or consumer and few or no substitutes, therefore their PED tends to be inelastic. Also describes goods that are income inelastic.

Synonyms

responsiveness . reaction/ sensitivity

eliminate..... remove/get rid of

Subject vocabulary

income elastic demand for a good is income elastic when the value of income elasticity of demand is greater than 1

luxuries when income changes demand for a luxury good changes at a greater rate. Demand is relatively sensitive to changes in income.

inferior goods goods for which demand falls as income increases

negative correlation a relationship between two variables such that they move in the opposite direction

market where buyers and sellers meet to exchange money for goods and services

manufactured goods goods produced from raw materials

output the quantity of goods produced by a firm, industry or economy

capital (goods) manufactured goods that are used in the production of other goods

primary good a good that has not been processed and is in a raw state (e.g. fruit/wheat)

direct taxes a tax that is paid directly by an individual or firm to the government. For example income tax on wages and company profits.

disposable income household income after direct taxation has been deducted

industry a group of firms that produce the same or similar goods or services

Synonyms

consumption.... use

When the proportional change in quantity demanded > the proportional change in income YED is greater than 1. This means that quantity demanded is highly responsive to changes in income. Demand is **income elastic** and goods are described as **luxuries**.

For example, incomes increase by 4% leading to a 6% increase in the quantity of taxi journeys demanded.

$$YED = \frac{\% \Delta Q_d}{\% \Delta Y} = \frac{6}{4} = 1.5 \quad YED > 1, \text{ therefore a taxi journey is a luxury service.}$$

Model sentence: As quantity demanded becomes more responsive to changes in income, demand becomes more income elastic and the positive value of YED increases.

Explain how a change in income affects demand in the case of inferior goods

In the case of inferior goods, as income increases demand falls, leading to a shift down and to the left of the demand curve and a fall in quantity demanded. As income falls demand increases, leading to a shift up and to the right of the demand curve and an increase in quantity demanded. YED is negative for an **inferior good** because there is a **negative correlation** between income and quantity demanded (income and quantity demanded change in opposite directions). A positive divided by a negative gives a negative and a negative divided by a positive gives a negative.

Calculation of YED

An increase in national income of 3% leads to a 1% fall in the quantity of bus journeys demanded.

$$YED = \frac{\% \Delta Q_d}{\% \Delta Y} = \frac{-1}{3} = -0.33$$

YED is negative, therefore a bus journey is an inferior service.

Explain the factors that affect YED

Consumers react differently to changes in their income because the amount of benefit gained from the **consumption** of a good varies from person to person. Goods that are luxuries to some are necessities to others.

If already on a very high income an increase in income might lead to no changes in the consumption of goods. In this case YED would be 0. (A number divided into zero = zero.)

Chicken is a luxury good in China. As incomes increase, quantity demanded increases at a greater rate. As incomes continue to increase, the value of YED for chicken will begin to fall. In time chicken might become income inelastic.

YED changes over the life of a good. Demand for mobile phones when first brought to **market** was income elastic. They were luxury goods. As price has fallen over time demand has become less income elastic. For many the good is no longer a luxury. Some models have become inferior goods. But in poorer countries demand will still be income elastic.

YED depends upon how the good is described. For example, demand for bread in general is income inelastic and a necessity, but demand for specialist bread, such as organic raisin and walnut bread, is income elastic and a luxury.

Explain how YED affects government and producers

A business can predict what will happen to demand when income changes if it knows the YED. When incomes are expected to increase firms producing luxury **manufactured goods**, such as iPads, and services, such as foreign holidays, will have to make plans if the firm wants to increase **output** in order to meet the higher levels of demand. The firm will need to employ and train more workers and buy new **capital**. When incomes are expected to fall the same firms would have to consider reducing the size of the work force and the size of production. The firm might also consider producing an inferior good. Firms can reduce the risk of business failure by producing a range of goods with different YED values.

Why is demand for primary goods income inelastic?

The demand for many **primary goods** is income inelastic. That is, the proportional change in income is greater than the proportional change in quantity demanded so the value of YED < 1. As incomes rise the demand for many primary goods such as tea, coffee, and sugar increases, but by a proportionately smaller amount. If income rose by 30% the percentage change in quantity demanded of sugar or tea would be much smaller.

YED and tax

Direct tax is a tax on income. It is called a direct tax because it goes directly from the payer of the tax to the government. Increasing tax reduces consumers' **disposable income** and causes a fall in demand for necessities and luxury goods and an increase in demand for inferior goods. This will have an impact on employment in those **industries** producing goods that have high positive and high negative YEDs.

Test your understanding of this unit by answering the following questions

- Organic bread has a YED of 4 and basic white bread has a YED of 0.1. Incomes are expected to increase by 5% next year. Calculate the percentage increase in quantity demanded for both types of bread.
- Discuss the **implications** of the expected increase in income for the bread-making industry.

Synonyms

implications effects/
outcomes

responsiveness ... reaction/
sensitivity

Learning Outcomes

- Explain the concept of price elasticity of supply, understanding that it involves responsiveness of quantity supplied to a change in price along a given supply curve.
- Calculate PES using the following equation

$$\text{PES} = \frac{\text{percentage change in quantity supplied}}{\text{percentage change in price}}$$
- Explain, using diagrams and PES values, the concepts of elastic supply, inelastic supply, unit elastic supply, **perfectly elastic supply**, and **perfectly inelastic supply**.
- Explain the determinants of PES, including time, mobility of factors of production, unused capacity, and ability to store stocks.
- Explain why the PES for primary goods is relatively low and the PES for manufactured goods is relatively high.

Why is there a positive correlation between price and quantity supplied?

As price increases, **ceteris paribus**, profit increases. Assuming that firms are profit maximizers they will allocate more **resources** to the production of the good that is now more profitable in order to increase **output**. As price rises output rises. When price falls profit falls and firms reduce output as it is now less profitable. **Price elasticity of supply** (PES) measures the **responsiveness** of quantity supplied to a change in price and is calculated using the formula $\text{PES} = \frac{\text{percentage change in quantity supplied}}{\text{percentage change in price}}$

Calculations of PES – a step-by-step guide

Trouble shooter

Price increases from \$8 to \$10 leading to an increase in quantity supplied from 8000 units to 9000 units. The formula used to calculate PES when the changes are in raw values is $\text{PES} = \frac{\Delta Q_s / Q_s}{\Delta P / P}$

ΔQ_s is the change in quantity supplied, Q_s is the original quantity supplied, ΔP is the change in price, and P is the original price.

$$\text{PES} = \frac{1000/8000}{2/8} \quad \text{simplify by dividing 1000 by 8000 and 2 by 8}$$

$$\text{PES} = \frac{0.125}{0.25} \quad \text{simplify by dividing 0.125 by 0.25}$$

$$\text{PES} = 0.5$$

The proportional change in quantity supplied (0.125) < the proportional change in price (0.25) therefore $\text{PES} < 1$ and supply is **price inelastic**.

Subject vocabulary

perfectly elastic supply at a particular price quantity supplied is infinite but falls to nothing as price changes. The absolute value of PES is equal to infinity.

perfectly inelastic supply quantity supplied does not change as price changes. PES equals zero.

ceteris paribus Latin phrase meaning 'all other things being equal' or 'all other things being held constant'

resources the inputs into the production process, the factors of production

output the quantity of goods produced by a firm, industry or economy

price elasticity of supply (PES) a measure of how quantity supplied responds to a change in price in percentage terms

price inelastic the percentage change in quantity demanded/supplied < the percentage change in price

Synonyms

correlation..... link/
relationship

shift(s)..... move(s)

Subject vocabulary

supply curve a graph that shows the relationship between price and quantity supplied

demand curve a graph that shows the relationship between price and quantity demanded

demand the amount of a good that consumers are willing and able to buy at each price

perfectly inelastic supply quantity supplied does not change as price changes. PES equals zero.

price unit elastic the percentage change in quantity demanded / supplied = the percentage change in price. PED/PES = 1

perfectly elastic supply at a particular price quantity supplied is infinite but falls to nothing as price changes. The absolute value of PES is equal to infinity.

factors of production the inputs into the production process (land, labour, capital and entrepreneurship)

output the quantity of goods produced by a firm, industry or economy

short run a period of time when at least one factor is variable and the others are fixed

capital (goods) manufactured goods that are used in the production of other goods

Glossary

slope the angle/gradient of the curve

When the changes are in percentage terms use the formula $PES = \frac{\% \Delta Q_s}{\% \Delta P}$

Price falls by 2% leading to a fall in quantity supplied of 3%. $PES = \frac{\% \Delta Q_s}{\% \Delta P} = \frac{-3}{-2} = 1.5$

The percentage change in quantity supplied (-3%) > the percentage change in price (-2%) therefore PES > 1 and supply is price elastic.

There is a positive **correlation** between quantity supplied and price (they change in the same direction), therefore PES is positive (a positive divided by a positive gives a positive and a negative divided by a negative gives a positive).

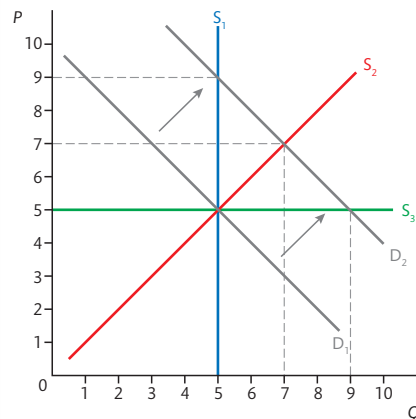


Figure 12.1

Figure 12.1 shows a demand and supply diagram with 3 **supply curves** each representing different values of PES. The **demand curve** shifts up and to the right from D_1 to D_2 . The rate of change in price and quantity supplied caused by an increase in **demand** varies depending on the initial price and quantity supplied and the **slope** of the supply curve. Keeping the initial price and quantity supplied unchanged, as S_1 rotates clockwise the slope becomes less steep. The proportional change in price caused by the same increase in demand falls and the proportional change in quantity supplied rises.

Supply curve 1

Demand increases and the demand curve shifts up and to the right from D_1 to D_2 . Price increases from \$5 to \$9 leading to no change in quantity supplied. Quantity supplied stays at 5 units.

$$YED = \frac{\Delta Q_s / Q_s}{\Delta P / P} = \frac{0/5}{4/5} = \frac{0}{0.8} = 0 \quad (0 \text{ divided by any number} = 0)$$

PES = 0, supply is **perfectly inelastic** with respect to price.

Supply curve 2

The demand curve shifts up and to the right. Price increases from \$5 to \$7 leading to an increase in quantity supplied from 5 units to 7 units.

$$PES = \frac{\Delta Q_s / Q_s}{\Delta P / P} = \frac{2/5}{2/5} = \frac{0.4}{0.4} = 1 \quad PES = 1, \text{ supply is } \textbf{price unit elastic}.$$

Supply curve 3

Demand curve shifts up and to the right. Price does not change but quantity supplied increases from 5 units to 9 units.

$$PES = \frac{\Delta Q_s / Q_s}{\Delta P / P} = \frac{4/5}{0} = \frac{0.8}{0} = \infty \quad (\text{any number divided by infinity} = \infty) \quad PES = \infty.$$

Supply is **perfectly elastic** with respect to price.

Model sentence: The less responsive quantity supplied is to a change in price the lower the value of PES and the more price inelastic the supply.

Factors that determine how responsive quantity supplied is to a change in price

Time

In the very **short run** (the time period immediately after a price increase) the **factors of production** are fixed and a firm cannot increase **output** so supply is perfectly inelastic with respect to price. In the short run the quantity of labour is variable (changeable) but the quantities of capital and land are fixed (unchangeable). The firm can only increase output by adding more labour to existing **capital** so supply is price inelastic. Output can

be increased by a relatively small amount by only adding labour. In the **long run** the quantities of all factors are variable, therefore the firm can employ more labour and buy more capital in order to increase output even more so supply becomes more **price elastic**. Over time quantity supplied becomes more responsive to a change in price. The value of PES increases, supply becomes more price elastic and the slope of the supply curve becomes less steep.

For **primary goods** quantity supplied is less responsive to changes in price. For example, a farmer decides which crops to grow a long time before the goods come to market. It takes a long time to move **resources** away from the production of one crop to the production of another. It is not possible to change the quantity supplied in the short term therefore supply of agricultural goods is more price inelastic. Manufactured goods are likely to be more price elastic than agricultural goods because it is easier for firms producing manufactured goods to reallocate their factors to different production processes and thereby increase output.

Capacity

When a firm is operating at full **capacity** (all the firm's labour and capital is being used) it is difficult to increase output. Supply is more **price inelastic**. A firm is able to increase output if it has **spare** capacity. The greater the amount of capital and labour not being used by the firm the more responsive quantity supplied is to an increase in price so supply is more price elastic.

Stocks

Quantity supplied can be increased when the firm is able to hold lots of stock. These are goods held in storage. Goods can be released onto the market very quickly, therefore supply is more price elastic.

Availability and mobility of resources

In order to increase output a firm must get more resources. In a period of high economic activity **unemployment** is very low. Workers are in **short supply**. **Raw materials** might not be available. When resources needed for the production of a good are in short supply, quantity supplied of that good is less responsive to increases in its price and supply is more price inelastic. When there is a slowdown in economic activity **demand** for resources is lower. More are available for firms to use. Quantity supplied can be increased more easily so supply is more price elastic.

There is a greater supply of **unskilled labour** than **skilled**. It is easier for firms that use unskilled labour to increase the size of the workforce in order to increase output, so supply is more price elastic. When specialized capital and skilled labour are needed, factors are less mobile. A firm will not be able to employ factors quickly in order to increase output so supply is more price inelastic.

Model sentence: When the factors used in the production of a good are easily available, firms in an industry can quickly employ them in order to increase output in response to an increase in price and therefore supply is more price elastic.

Test your understanding of this unit by answering the following questions

- Price of corn increases by 10% leading to an increase in quantity supplied of 1%. Comment on the value of PES.
- Explain why PES becomes more elastic over time.
- Explain why PES is likely to be more inelastic during high levels of economic activity.

Subject vocabulary

long run a conceptual moment in time when all factors are variable

price elastic the percentage change in quantity demanded/supplied > the percentage change in price

primary good a good that has not been processed and is in a raw state (e.g. fruit/wheat)

resources the inputs into the production process, the factors of production

price inelastic the percentage change in quantity demanded/supplied < the percentage change in price

unemployment occurs when there are people actively looking for work at the equilibrium wage rate but are not able to find work

short supply the amount demanded is greater than the amount supplied

raw material the basic material from which a good is made

demand the amount of a good that consumers are willing and able to buy at each price

unskilled labour workers lacking in skills, training, and education

skilled labour workers who are well trained, well educated, and who are experts in their field

Glossary

capacity the amount of something a firm is able to make

Synonyms

spare extra